R&D Performance Measures for Government Research

Gregory Tassey

Senior Economist

National Institute of Standards and Technology

tassey@nist.gov

http://www.nist.gov/director/planning/strategicplanning.htm

Topics

- Introduction (slides 2-4)
- Economic context (slides 5-7)
- Key issues in R&D performance measurement (slides 8-10)
- NIST's approach to performance measurement (slides 11-15)
- Microeconomic impact assessment (slides 16-20)

National Institute of Standards and Technology

NIST strengthens the U.S. economy and improves the quality of life by working with industry to develop and apply technology, measurements, and standards.

NIST Assets Include:

- World leadership in measurement capabilities
- 3,200 employees
- 1,600 scientists and engineers
- $720 million annual budget
- 1,200 industrial partners
- 2,000 field agents
- 1,600 guest researchers

NIST's Major Programs

NIST Laboratories

Nation's ultimate reference point for measurements and standards to support industry, science, health care, safety, and the environment.

Baldrige National Quality Program

Annual Baldrige awards in manufacturing, service, small business, education, and health care promote business excellence.

Advanced Technology Program

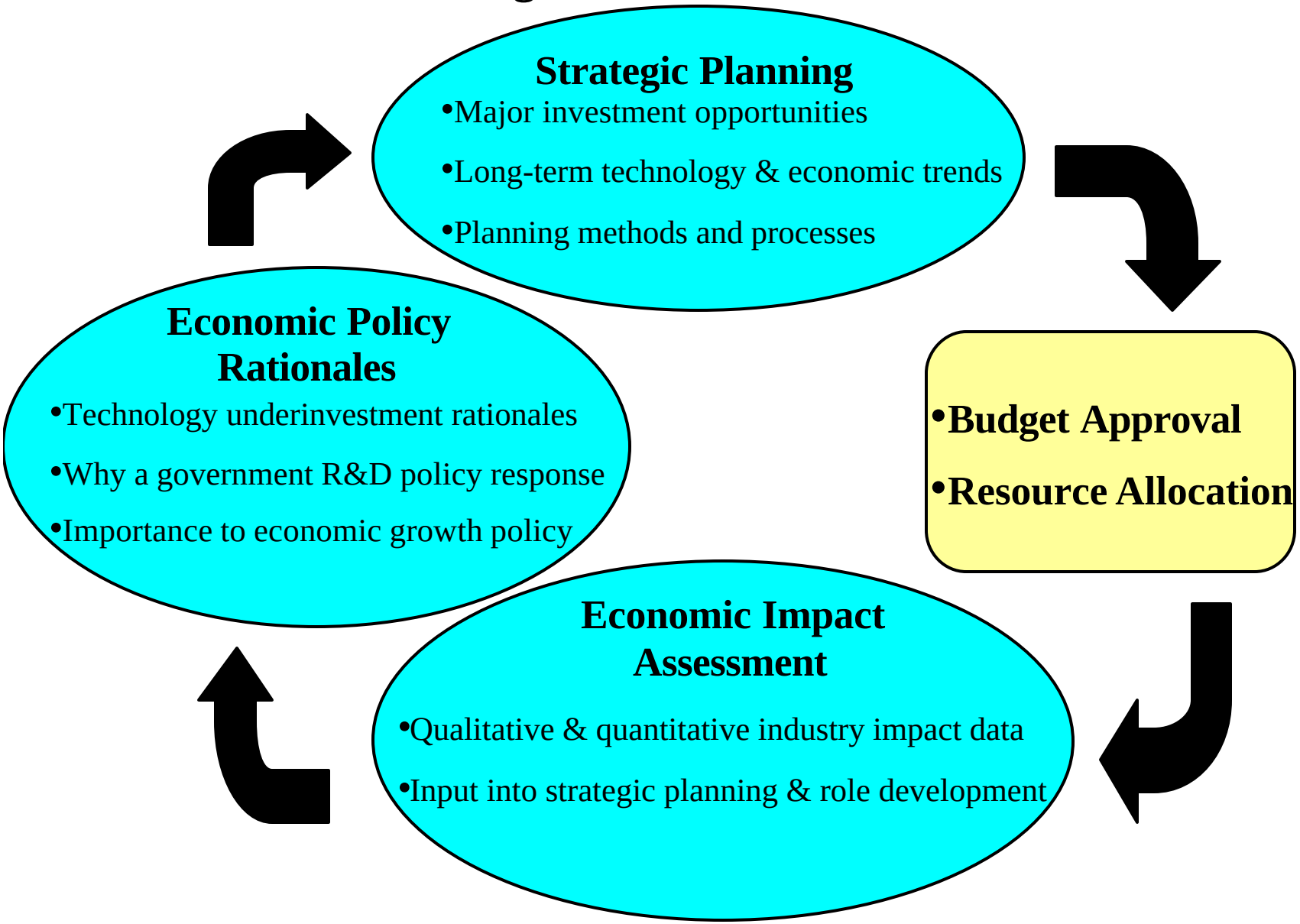
Co-funding of private sector R&D to develop broadly beneficial new technologies.

Manufacturing Extension Partnership

Nationwide network of extension centers assisting the Nation's 361,000 smaller manufacturers.

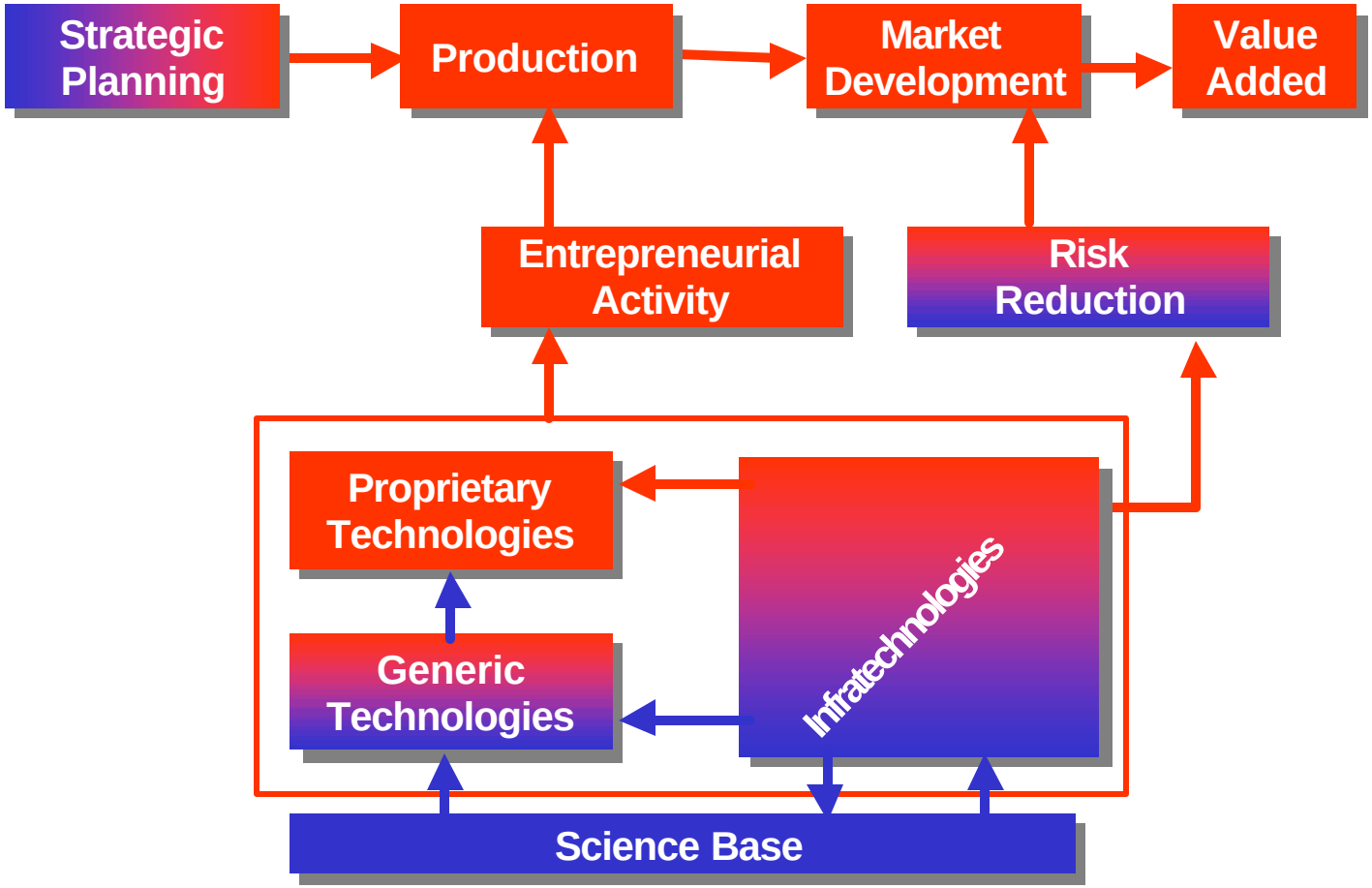
Economic Context

Economic and Planning Functions in for Government R&D



Economic Context

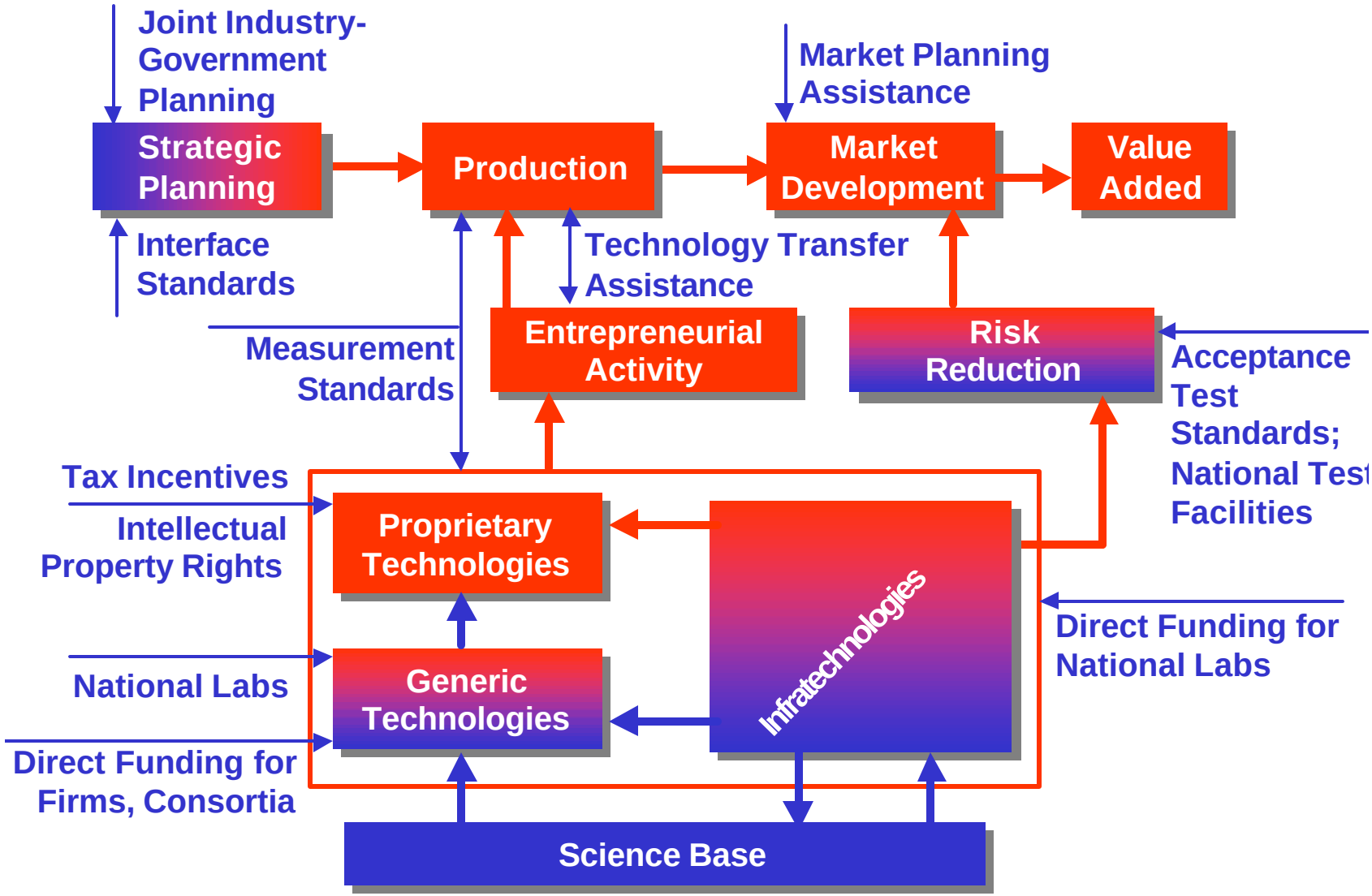
Economic Model of a Technology-Based Industry



Source: G. Tassey, *The Economics of R&D Policy*, Quorum Books, 1997, p. 70

Economic Context

Technology-Based Growth Policy Responses



Issues

Target Audience Affects Performance Metrics

- **External**
  - -- S&T and economic policy arenas
  - -- industry constituents
  - -- budget process
  - -- financial statements
  - -- GPRA
- **Internal**
  - -- management
  - -- planning process

Issues

Performance Metrics Vary By End Use

- **GPRA**
  - -- regular, consistent reporting
  - -- primarily output measures for R&D programs
  - -- emphasize fit between budget structure and metrics
- **Program Management & Strategic Planning**
  - -- post commercialization
  - -- in depth microeconomic analyses
  - -- performance measures tailored to type of technical infrastructure

Issues

Measuring Impact

- Inputs
  -- “activity” counts are easiest to compile
  -- cost accounting may not match project content

- Outputs
  -- occur irregularly in research projects
  -- change over project life cycle

- Outcomes
  -- economic
  -- take time to be realized
  -- can extend over long periods

NIST's Approach: Output Metrics

- **NIST Laboratories: Infratechnologies**
  - -- measurement and test methods
  - -- science and engineering databases
  - -- simulation models
  - -- interface protocols
  - -- test artifacts (SRMs) & services (calibrations)

- **ATP: Generic Technologies**
  - -- cumulative technologies commercialized
  - -- cumulative publications
  - -- cumulative patents filed

NIST's Approach: Output Metrics

- **MEP: Technology Transfer**
  -- number of firms assisted or projects completed
  -- investments/practices changed

- **Baldrige National Quality Program**
  -- number of firms adopting criteria

NIST's Approach: Outcome Metrics

- Investment
- Sales
- Employment
- Profits
- Value added

NIST's Approach: Outcome Measures--Quantitative

Example: Profit Measures

- Net Present Value
- Benefit-Cost Ratio
- Social (Internal) Rate of Return

NIST's Approach: Outcome Measures-- Qualitative

Emphasis on Technology—Infrastructure Interactions

- Variations in impacts over the technology life cycle
  -- Impacts on R&D, production, marketing
  -- project timing over technology life cycle
  -- identification of related industry needs
- Impacts on corporate strategy
  -- R&D, production, marketing decisions
  -- investment timing

Microeconomic Impact Assessment

Elements of Economic Impact Studies

Technology and Industry Overview

- Technology trajectories
- Industry structure and competitive dynamics
- Infratechnology trajectories
- Infratechnology market failures
- NIST infratechnology roles

Economic Analysis Framework

- Identification of economic functions of NIST technical outputs
- Development of hypothesized economic outcomes
- Construction of economic outcome measures
- Selection of study period

Data Collection Plan

- Specification of cost elements
- Determination of industry populations and sampling strategies
- Selection of survey methods
- Industry introductions from NIST
- Pretest survey
- Conduct surveys
- Collect cost data

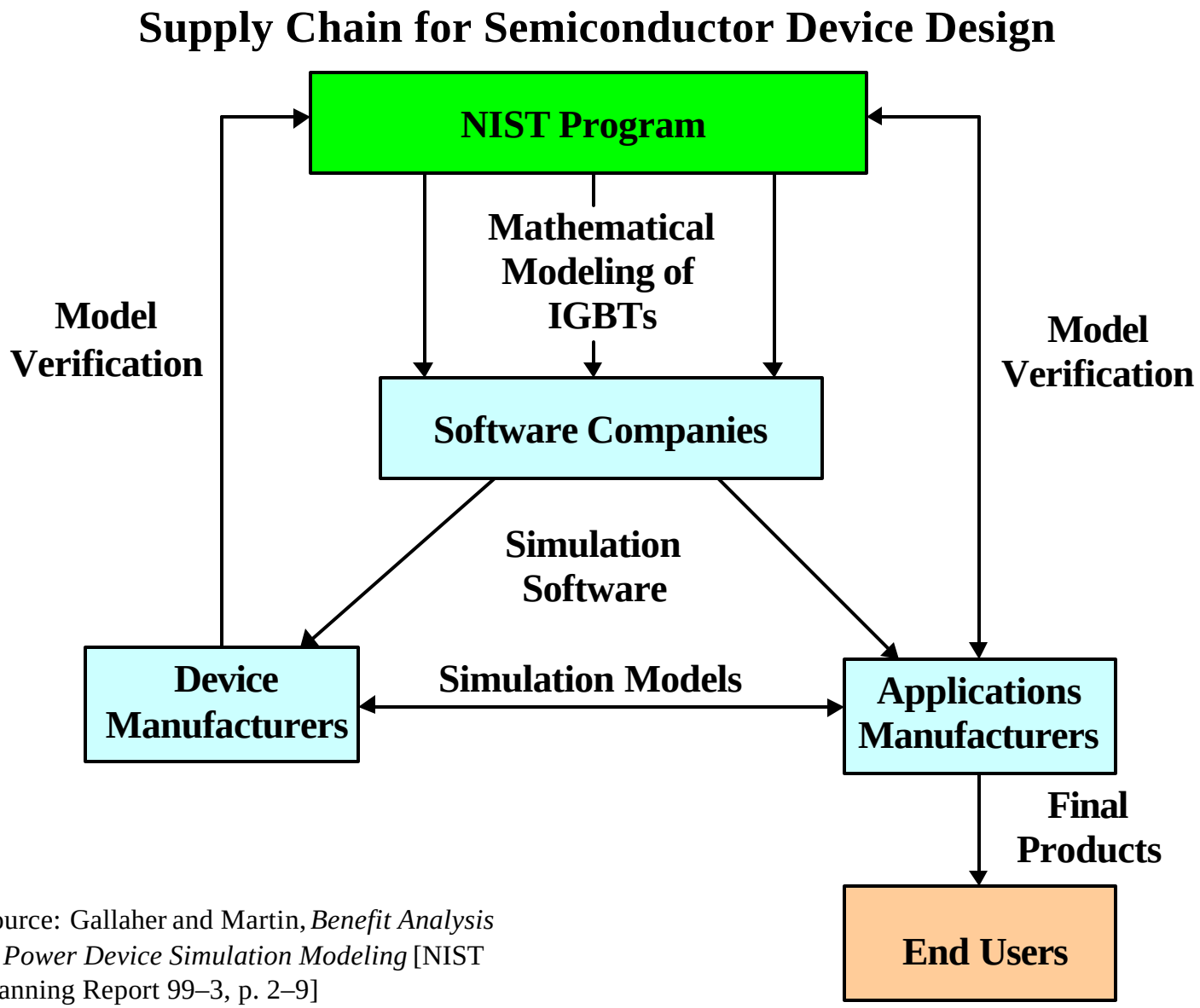
Economic Impacts

- Quantitative analysis
- Qualitative analysis

Results

- Draft report
- Final report
- Oral briefings
- Publications

Microeconomic Impact Assessment



Source: Gallaher and Martin, *Benefit Analysis of Power Device Simulation Modeling* [NIST Planning Report 99–3, p. 2–9]

Microeconomic Impact Assessment

Software for Semiconductor Design Automation: Economic Sectors and Related Benefit Categories				
Sectors	***R&D Efficiency***	***Transaction Costs***	***Production Costs***	***Product Quality***
Software Companies	Qual			
Device Manufacturers		**Quan**		
Applications Manufacturers	**Quan**	Qual	Qual	
End Users				Qual

Microeconomic Impact Assessment

Outputs and Outcomes of NIST Laboratory Research			
Industry/Project	**Output**	**Outcomes**	**Measure**
Chemicals: alternative refrigerants	Standard reference data	Increase R&D efficiency Increase productivity	SRR: 433% BCR: 4 NPV: $11.7M
Semiconductors: design automation (IGBT semiconductors)	Software model	Increase R&D efficiency Increase productivity	SRR: 76% BCR: 23 NPV: $17M
Pharmaceuticals: cholesterol measurement	Measurement method Standard reference materials	Increase productivity Reduce transaction costs	SRR: 154% BCR: 4.5 NPV: $6.2M
Photonics: laser and fiberoptic power and energy calibration	Calibrations	Increase productivity Reduce transaction costs	SRR: 43%–136% BCR: 3–11 NPV: $48M
Chemicals: SRMs for sulfur in fossil fuels	Measurement method Standard reference materials	Increase productivity Reduce transaction costs	SRR: 1,056% BCR: 113 NPV: $409M

Microeconomic Impact Assessment

Summary of R&D Performance Information

- **Quantitative metrics** have strong effect on S&T policy
  - -- increases as database expands
  - -- benefits from learning curve effect
  - -- requires high quality & expensive data collection
- **Qualitative analyses** contribute to strategic planning
  - -- context for interpreting quantitative impacts
  - -- predict impacts over technology life cycle
  - -- manage project timing
- **Economic role analysis**
  - -- reinforcement and refinement